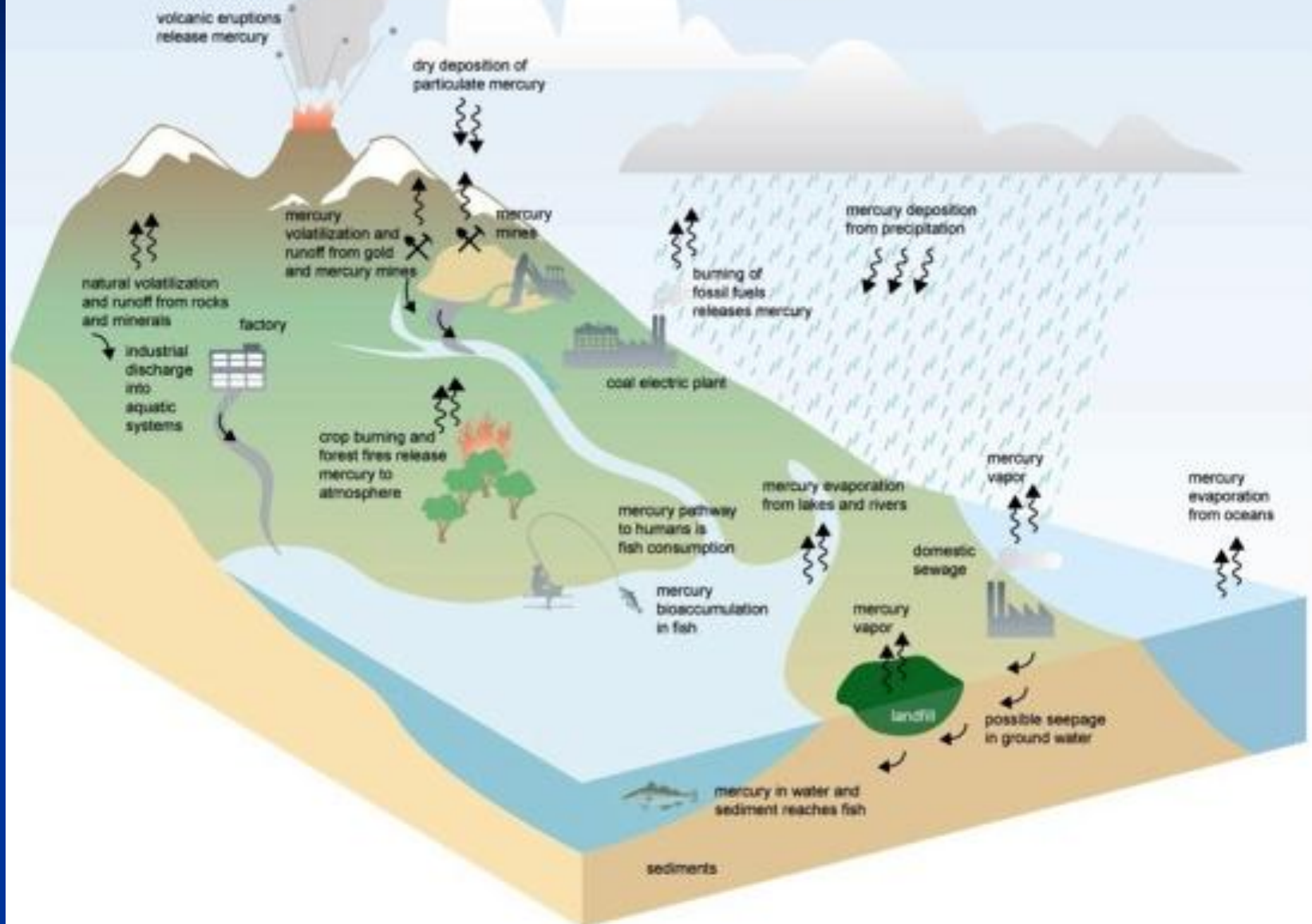


Mercury in Utah: Should you be concerned?

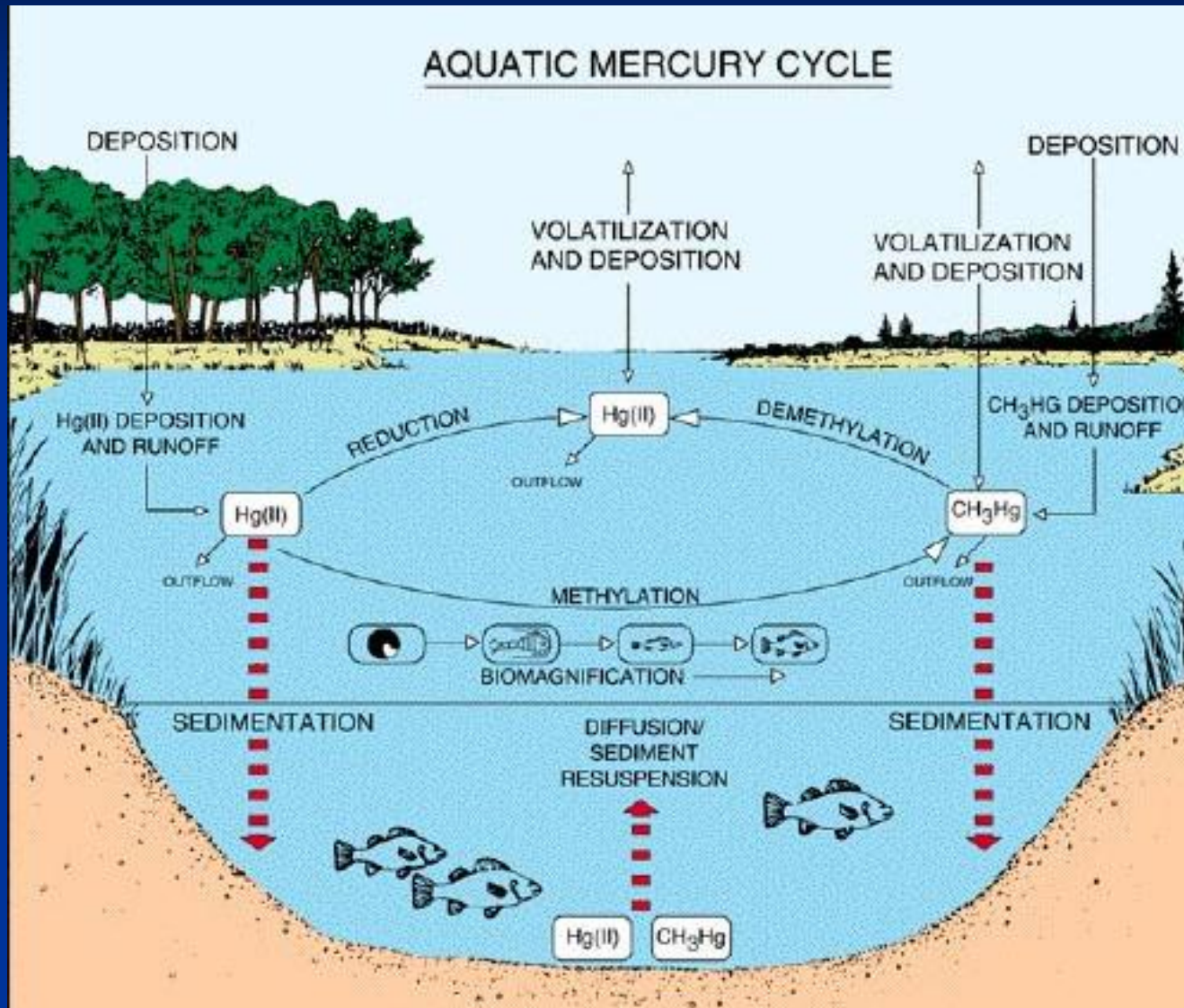


Jodi Gardberg, Great Salt Lake Watershed Coordinator and a
Statewide Mercury Coordinator
Utah DEQ, Division of Water Quality

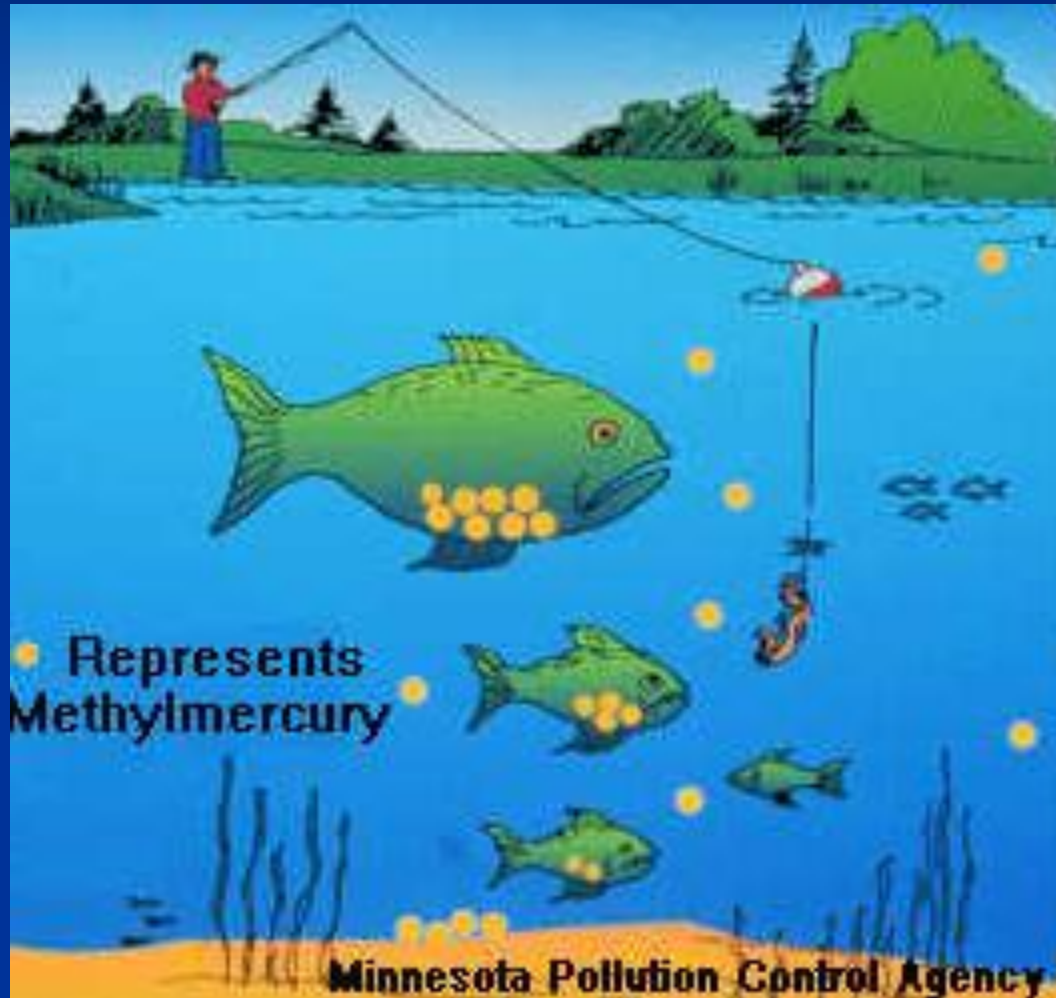
The Mercury Cycle



Mercury in Water



Bioaccumulation of Methyl Mercury (MeHg)



Toxic Effects of MeHg to Humans

- Neurotoxin
- Impacts the immune system
- Alters genetic and enzyme systems
- Particularly damaging to developing embryos

Most Vulnerable Group: Pregnant Woman, Nursing Mothers and Young Children

- Methylmercury easily passes from the mother's bloodstream to the fetus
- Methylmercury has been found in mother's breast milk
- Young children < 4-6 years of age:
 - Rapidly absorb nutrients, inorganics from the stomach
 - Have rapidly developing neurological systems

National Health Advisory for Women of Child-bearing Age and Young Children

1. Do not eat swordfish, shark, king mackerel or tile fish
2. Eat up to 12 oz./week of fish that are lower in mercury: shrimp, canned light tuna, salmon, pollock and catfish. Albacore (“white”) has higher levels of mercury; consume only 6 oz./week
3. If no advisory is available, eat up to 6 oz./week (1 average meal) but don’t consume any other fish during that week

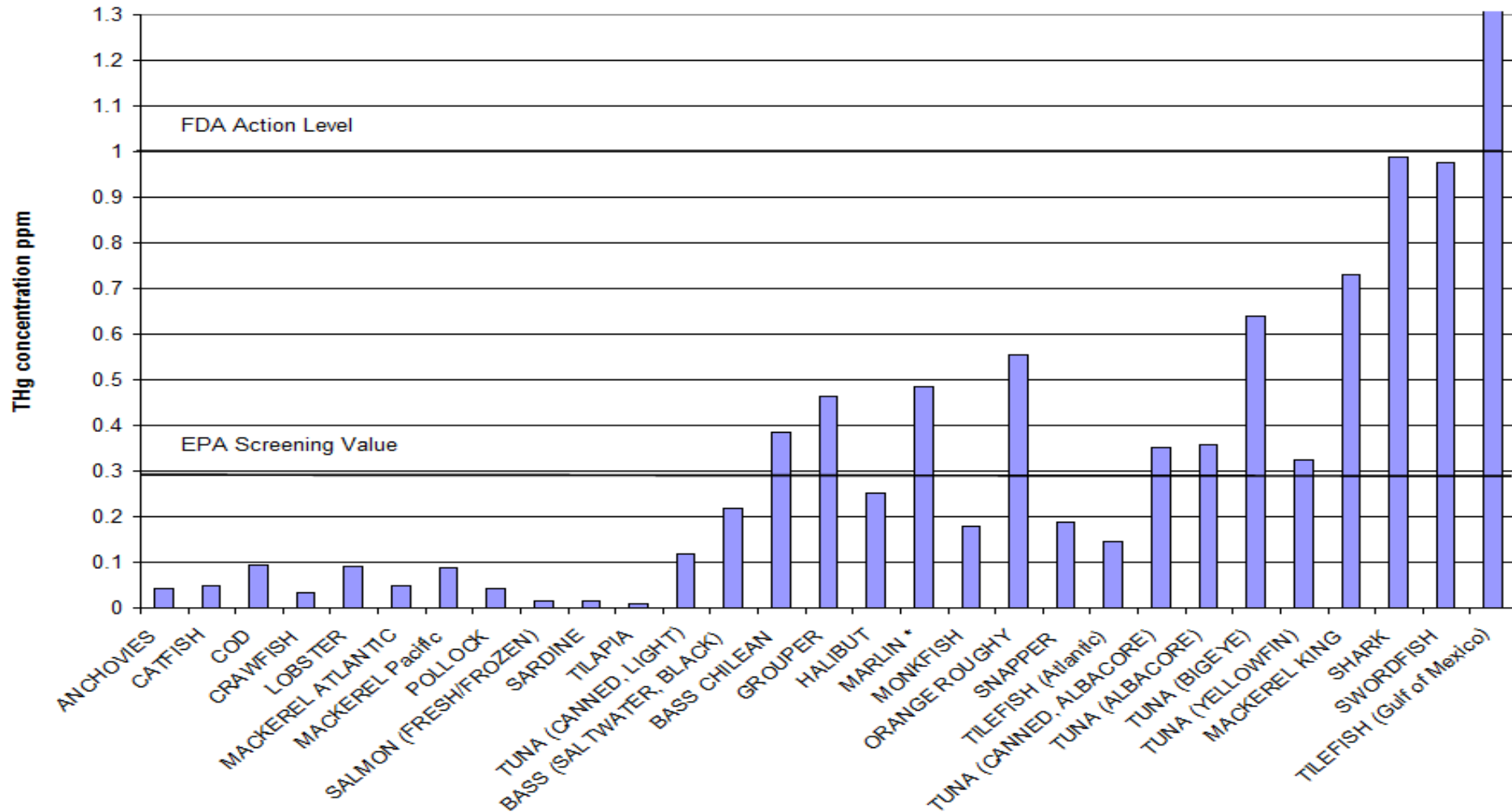


Environmental Protection Agency versus Food and Drug Administration

EPA Screening Value (SV) = 0.30 mg of
mercury/kg of fish tissue (mg/kg = ppm)

FDA Action Level = 1 mg/kg or 1 ppm

FDA Mercury Levels in Commercial Fish



Do Benefits of Eating Fish Outweigh the Risks?

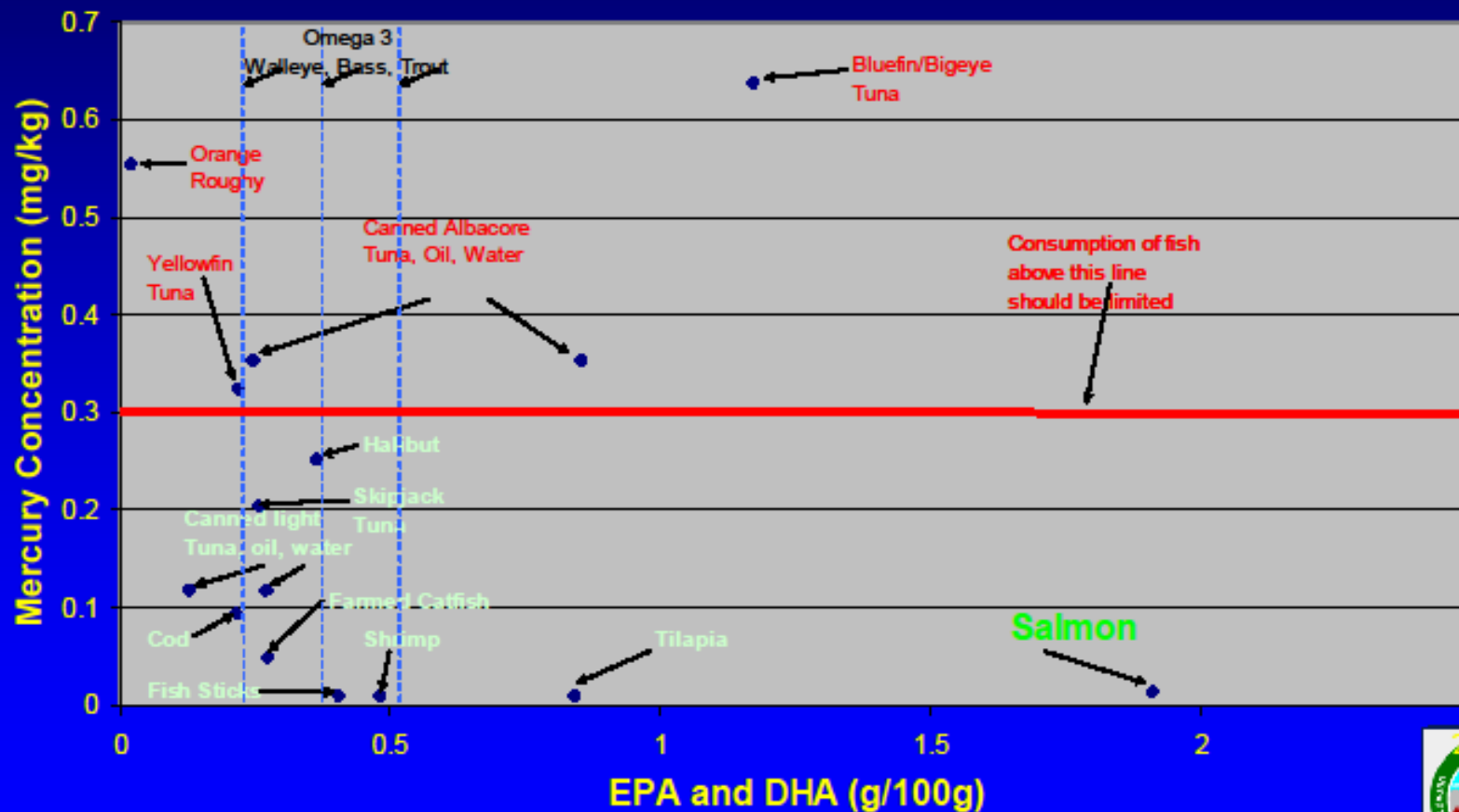
■ Benefits of Fish Consumption

- Good source of protein, low in saturated fat
- Contains Omega 3 Fatty Acids – great for the heart
- AHA recommends eating 2 servings (3.5 oz) per week
- AHA recommends patients with CHD to consume 1000 mg/day of EPA (**eicosapentaenoic acid**) plus DHA (**docosahexaenoic acid**), the main components of fish oils.
- DHA is beneficial for fetal and early childhood neurodevelopment

■ Risks of Fish Consumption

- Toxicity issues

EPA and DHA (Omega 3 Fatty Acids) vs Mercury Content



Eat Fish, Choose Wisely

Utah Fish Consumption Advisories

For more information:

www.fishadvisories.utah.gov



801-538-4700



801-538-6191



UTAH DEPARTMENT OF
ENVIRONMENTAL QUALITY

801-536-4400

Utah Fish Advisories



38 lb Striper from Lake Powell (Hg concentration 1.01 ppm)

Mercury Advisory Process

- Collect fish and or waterfowl (DWR - Division of Wildlife Resources & DWQ - Division of Water Quality)
- Laboratory preparation and analysis (EPA)
- Assure adequacy of data set (DWQ)
- Human health assessment (DOH - Department of Health)
- Coordination with DOH, DWR and DWQ
- Joint Advisory Issued





Total Fish Sampled = 2566 fish

Total Sites Visited = 322 sites

River Sites = 200

Lake/Reservoir Sites = 122

Number of Species = 35

Utah: Mercury Sampling Sites and Consumption Advisories

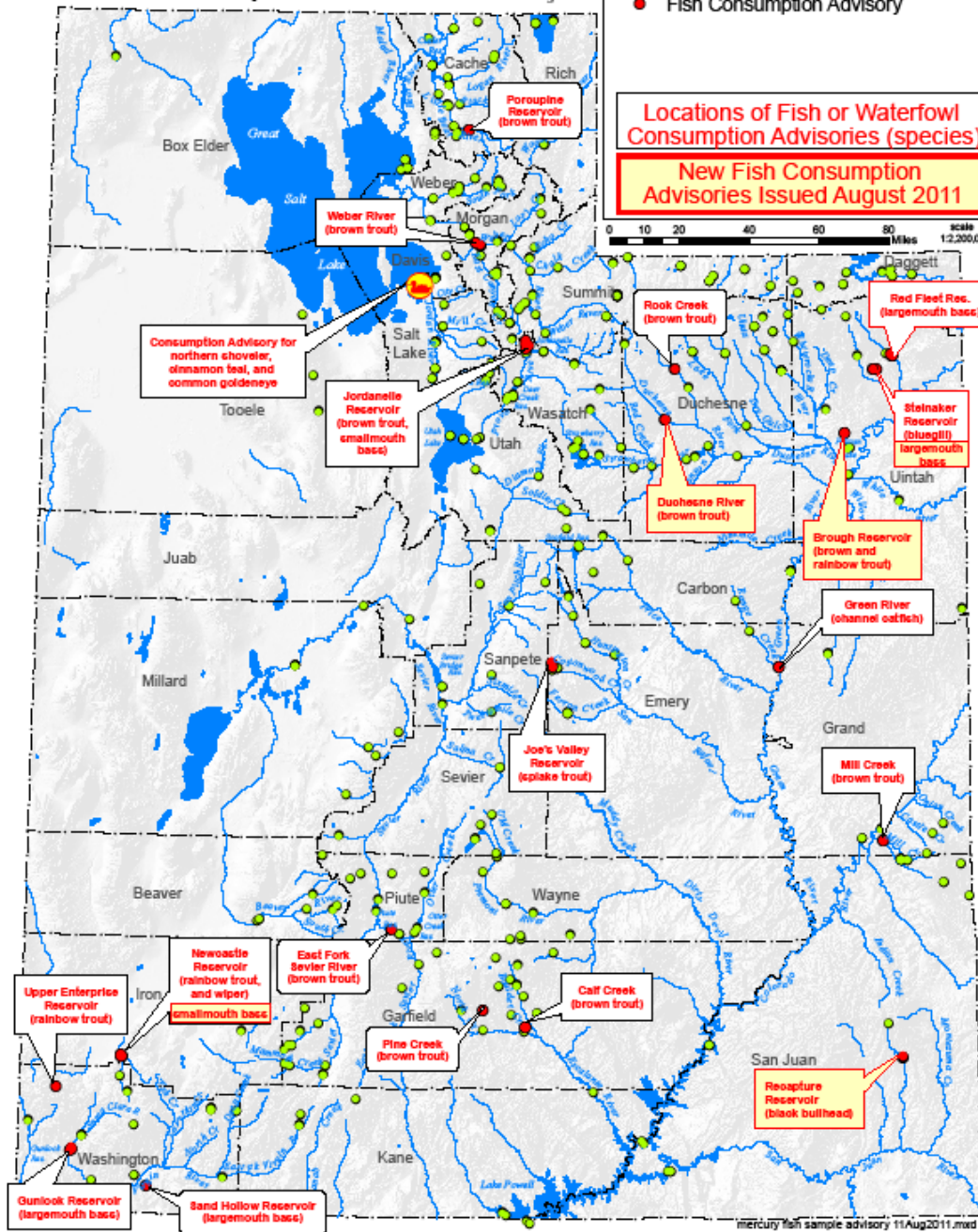


- Mercury Sampling Results**
- No Fish Consumption Advisory
 - Fish Consumption Advisory

Locations of Fish or Waterfowl Consumption Advisories (species)

New Fish Consumption Advisories Issued August 2011

0 10 20 40 60 80 Miles scale 1:2,200,000



Mercury Sampling Sites and Consumption Advisories Map

18 Locations

River Sites = 8

Lake/Reservoir Sites = 11



www.fishadvisories.utah.gov/

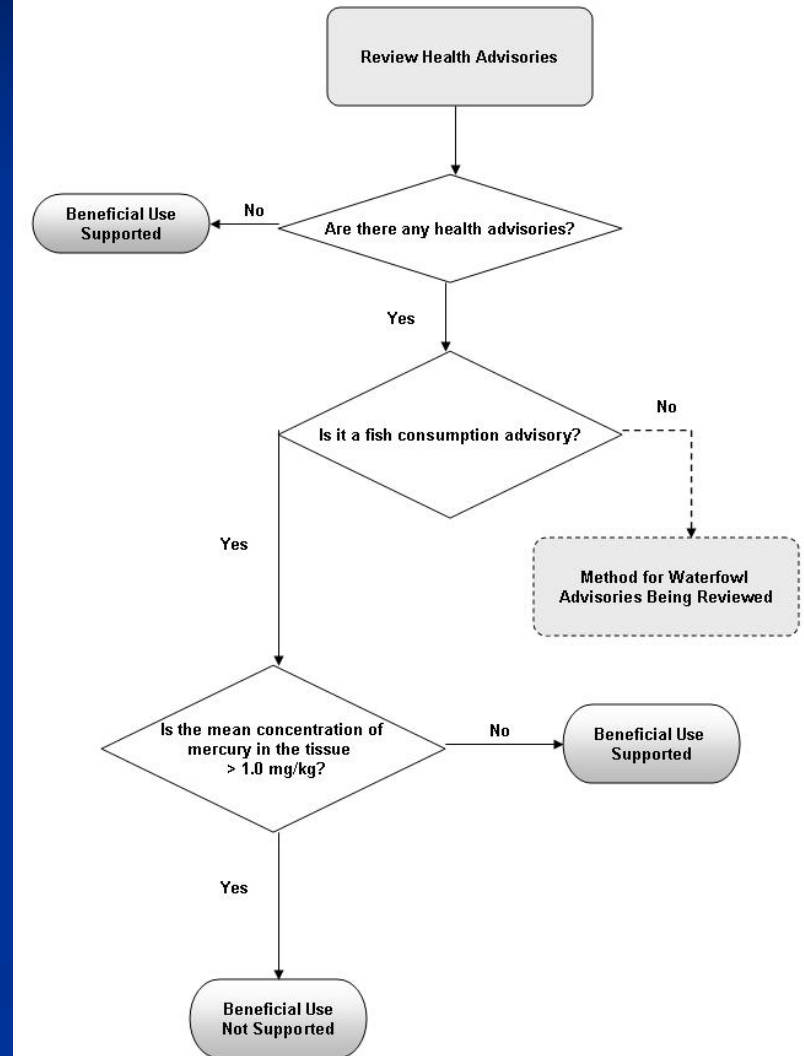
Mercury Hotspot – Southwestern Utah

EPA Screening Value = 0.3 ppm

Location	Year	Species	Pregnant Woman and Children (4 oz meal/month)	Adult (8 oz meal/month)	Mean Mercury concentration (ppm)
Newcastle Reservoir	2006	Rainbow Trout	Do Not Eat	1 serving	0.48
	2008	Wiper (>2 lbs)	Do Not Eat	Do Not Eat	1.40
	2011	Smallmouth Bass	Do Not Eat	1 serving	
Upper Enterprise Reservoir	2006	Rainbow Trout	Do Not Eat	1 serving	0.66
Gunlock Reservoir	2005	Largemouth Bass	1 serving	2 servings	0.42
Sand Hollow Reservoir	2007	Largemouth Bass	Do Not Eat	2 servings	0.41

New Castle Reservoir – Impaired

- Listed as Impaired on the 303 (d) list
- Beneficial Use Not Supported
 - Fish consumption advisory for mercury is in place and fish tissue mercury concentration is greater than ($>$) 1.0 mg/kg.



Using thermocline manipulation to restore mercury-contaminated reservoirs in southwestern Utah



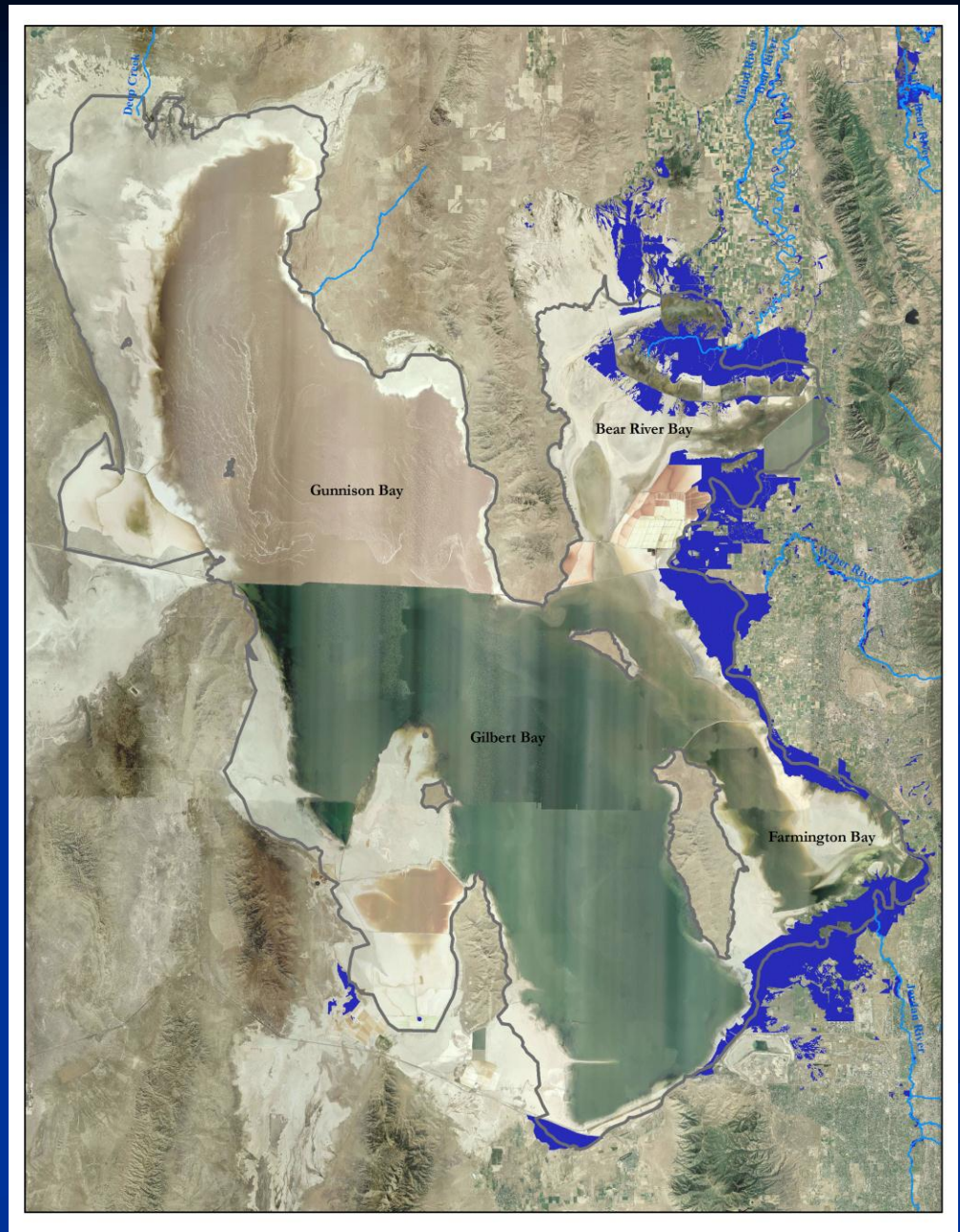


2008 Mercury Ecosystem Assessment of Great Salt Lake

photo - Charles Uibel - greatsaltlakephotos.com

Great Salt Lake

- ❑ Fourth largest terminal lake in the world
- ❑ Typically 3 to 5 times saltier than the ocean
- ❑ Supports 7.5 million birds annually and is part of the Western Hemisphere Shorebird Reserve Network
- ❑ 80% (427,000 acres) of Utah's Wetlands reside along Great Salt Lake





Mercury in water and biota from Great Salt Lake, Utah: Reconnaissance-phase results

David Nightz, USGS, Salt Lake City, UT; Bruce Waddell, USFWS, Salt Lake City, UT; and David Krabbenhoft, USGS, Madison, WI



Little is known about Hg cycling in Great Salt Lake

Great Salt Lake



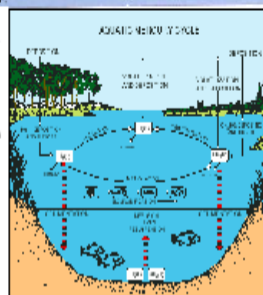
Mercury sources adjacent to GSL

Great Salt Lake (GSL) is the fourth largest terminal lake in the world and may be the most important inland shoreline site in North America (Aldrich and Paul, 2002). In addition to supporting migratory dependent waterbirds, the brine shrimp (*Artemia franciscana*) population residing in GSL supports a shrimp industry with annual revenues typically exceeding 100 million dollars. Atmospheric deposition is presently the major mercury (Hg) source to most aquatic ecosystems (Krabbenhoft and Rickett, 1995). Based on statistics published in 1997, numerous local point sources for atmospheric Hg deposition to GSL exist (U.S. Environmental Protection Agency, 1997). Based on data compiled from the 1990s, annual Hg deposition adjacent to GSL is elevated, ranging from 3 to 50 kg/ha.

U.S. Environmental Protection Agency, 1997

Mercury methylation in GSL

The lipophilic nature of methylmercury (CH₃Hg) and its ability to pass the blood-brain barrier makes it much more toxic to organisms than inorganic forms of Hg. The chemical and physical conditions present in GSL may be ideal for high rates of Hg methylation. Previous work has shown that marine sediments rich in organic matter and dissolved sulfide have rapid CH₃Hg production rates in conjunction with rapid rates of sulfate reduction (King and others, 2000). Sulfate reduction is the principal process leading to the production of CH₃Hg. Rates measured in water from GSL were higher than 6,000 nmol/m²/day, one of the highest rates reported in a natural environment (Ingervsen and Strand, 2002).

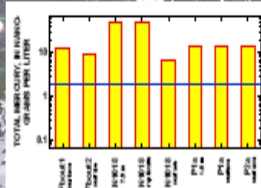
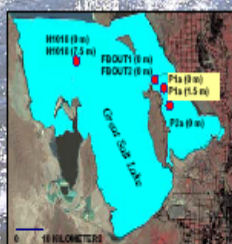


Mercury Pollution: Integration and Synthesis, 1994

Elevated concentrations of total Hg found in water

Aquatic life standard exceeded

During August 2003, unfiltered water samples were collected from the south arm of GSL. Samples were analyzed for total Hg and CH₃Hg concentrations by the USGS mercury research laboratory in Madison, Wisconsin. Initial results indicate high levels of total Hg (exceeding 45 nanograms per liter (ng/L) and CH₃Hg (exceeding 25 ng/L) in anoxic regions of the lake where high rates of bacterial-mediated sulfate reduction have been documented. The concentration of CH₃Hg measured in GSL is among the highest ever measured by the USGS mercury laboratory.



Total mercury concentration standard in water from marine systems for protection of aquatic life when methyl mercury is 5 percent of the total mercury concentration (British Columbia Ministry of Environment, Lands and Parks, 2001)

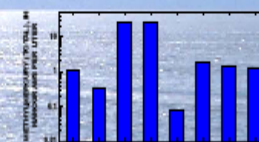
Elevated levels of methyl Hg found in water

Deep brine layer contains methylmercury

Percentage of total Hg concentration as methyl Hg in water samples collected from Great Salt Lake, August 2003.

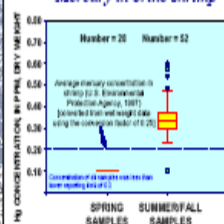
Sample site	Methylmercury as percent of total mercury
FBOUT1 (0 m depth)	8.0
FBOUT2 (0 m depth)	3.7
FBOUT3 (0 m depth)	55
FBOUT4 (0 m depth)	51
FBOUT5 (0 m depth)	1.2
FBOUT6 (0 m depth)	12
FBOUT7 (0 m depth)	9.2
FBOUT8 (0 m depth)	9.3

All of the water samples from GSL exceed the total Hg standard for protection of aquatic life in marine systems (British Columbia Ministry of Environment, Lands and Parks, 2001). This standard is based on the ratio of CH₃Hg to total Hg concentrations. In water samples with CH₃Hg making up 5 percent of the total Hg concentration, the standard is 2 ng/L (total Hg). The aquatic life standard increases as the proportion of CH₃Hg relative to total Hg decreases. The percentage of CH₃Hg contributing to total Hg in water samples collected from GSL ranges from 1.2 to 55 percent.

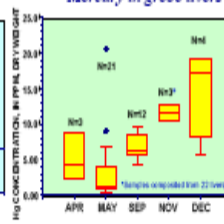


Hg content in biota indicates bioaccumulation

Mercury in brine shrimp



Mercury in grebe livers



The migration and molting habits of eared grebes make them an ideal population for the reconnaissance evaluation of Hg bioaccumulation. A large population of eared grebes (1.5 million in 1997) from throughout North America utilize GSL during the molt migration beginning in August and continuing through December and January (Aldrich and Paul, 2002). The seasonal changes in Hg concentration in eared grebe livers indicate bioaccumulation during the fall molting period when the grebes feed exclusively on brine shrimp. Brine shrimp samples collected during the summer and fall have a higher Hg concentration (median concentration = 0.34 ppm), with 51 out of 52 samples exceeding the average Hg concentration in shrimp of 0.18 ppm (U.S. Environmental Protection Agency, 1997). Total Hg and CH₃Hg levels in GSL water and biota appear elevated when compared to standards intended to protect aquatic life, however, the amount of data presently available is limited and further study is warranted.

References

- Aldrich, T.W., and Paul, D.S., 2002. Avian ecology of Great Salt Lake. In: Gentry, J.W., ed. Great Salt Lake: An overview of change. Utah Department of Natural Resources Special Publication, p. 340-374.
- British Columbia Ministry of Environment, Lands and Parks, 2001. Ambient water quality guidelines for mercury. Overview report—Final update. accessed September 22, 2004. <http://www.gov.bc.ca/eh/2001/20010922/guidelines/mercury.htm>
- Ingervsen, K., and Strand, K.K., 2002. Atmospheric chemistry and sulfur cycling in hypersaline ecosystems with special reference to Great Salt Lake. In: Gentry, J.W., ed. Great Salt Lake: An overview of change. Utah Department of Natural Resources Special Publication, p. 387-399.
- King, J.K., Kneib, J.R., Fletcher, M.R., and Saunders, P.M., 2000. Biotransformation of methylmercury at variable rates in pure culture and marine sediments. Applied and Environmental Microbiology, vol. 66, no. 6, p. 2408-2417.
- Krabbenhoft, D.P., and Rickett, D.A., 1995. Mercury contamination of aquatic ecosystems. U.S. Geological Survey Fact Sheet 218-95, 4 p.
- Mason, R.P., and Rickett, D.A., 2003. Mercury and methylmercury concentrations in water and biota from Great Salt Lake. In: Gentry, J.W., ed. Great Salt Lake: An overview of change. Utah Department of Natural Resources Special Publication, p. 375-386.
- U.S. Environmental Protection Agency, 1997. Mercury study report to Congress. EPA/600/R-97/004.

In 2003, USGS measured some of the highest levels of Hg found in U.S. surface waters

Waterfowl Advisories

Northern Shoveler

Average 3.22 ppm THg



Common Goldeneye

Average 2.01 ppm THg



Cinnamon Teal

Average 0.42 ppm THg



Adults should not eat more than 1 8 oz meal per month and pregnant women and children should not eat at all

www.waterfowladvisories.utah.gov/advisories.htm

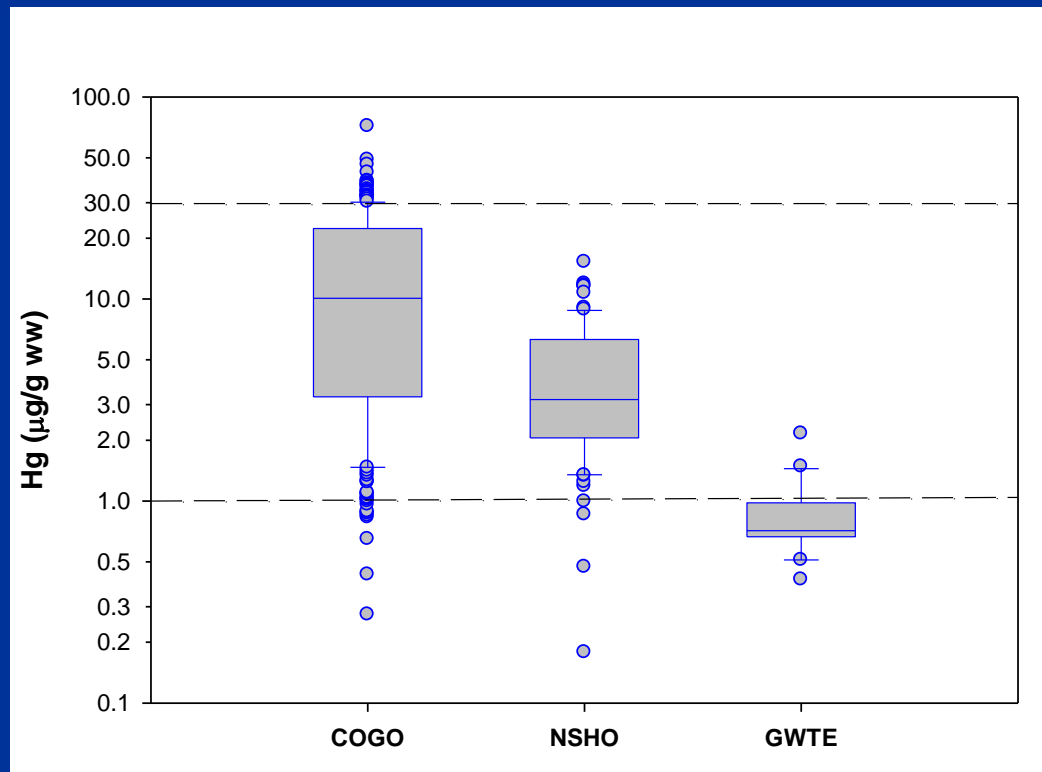
Mercury in Wintering Waterfowl

J. L. Vest, Utah State University

M. R. Conover, Utah State University

C. Perschon, Utah Division of Wildlife Resources

J. Luft, Utah Division of Wildlife Resources



Mercury in the Water Column and Sediment

Dave Naftz, US Geological Survey

■ THg water column

■ Total: 48 samples

■ Shallow brine: 36 samples

■ Deep brine: 12 samples

■ THg sediment 58 samples



Mercury in the Avian Species

John Neil, Great Salt Lake Ecosystems Project, Division of Wildlife Resources

Chris Cline, US Fish and Wildlife Service

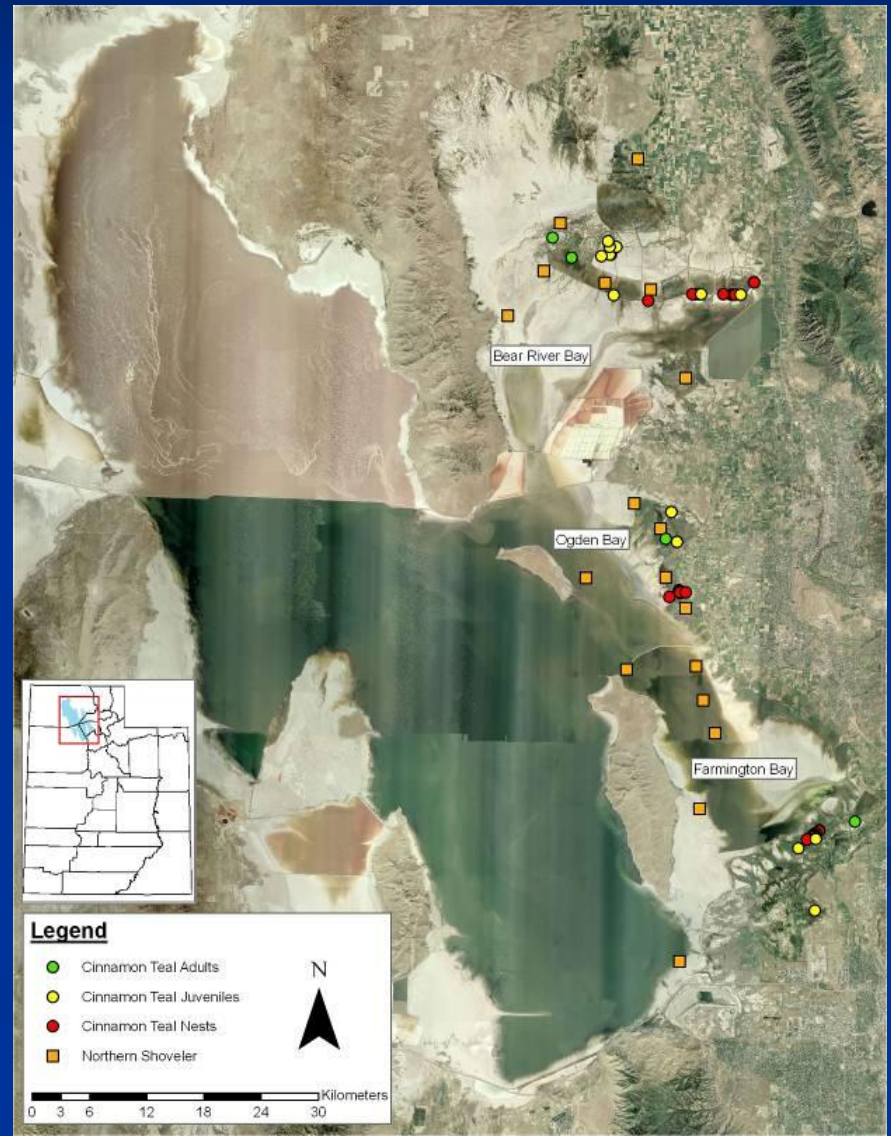


- THg and meHg in Cinnamon Teal

- Eggs – 30 samples (10 from each bay)
- Juveniles – 21 samples
- Adults – 29 samples

- THg and meHg in Northern Shovelers

- Adults – 48 samples

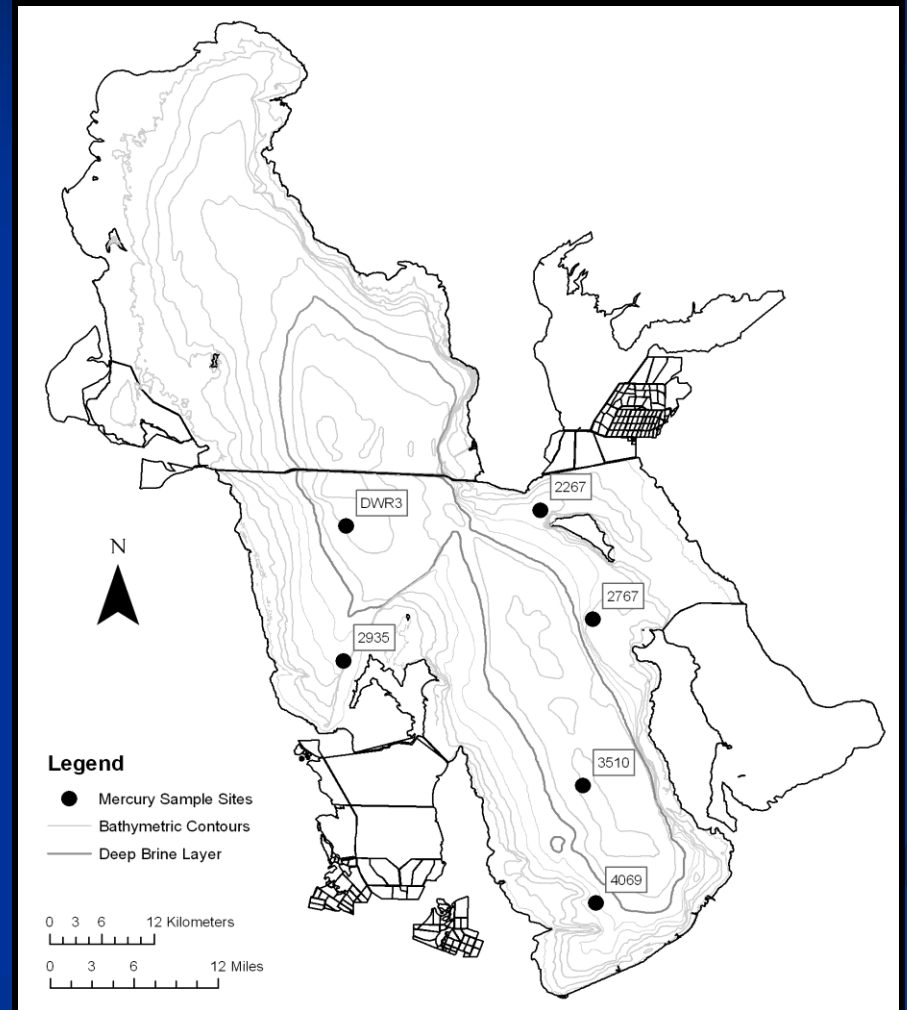
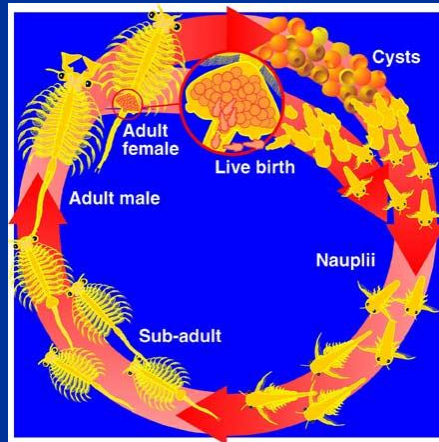


Mercury in the Avian Diet

Jim Van Leuwen and Phil Brown, Great Salt Lake Ecosystems Project, Division of Wildlife Resources

■ THg in Brine Shrimp

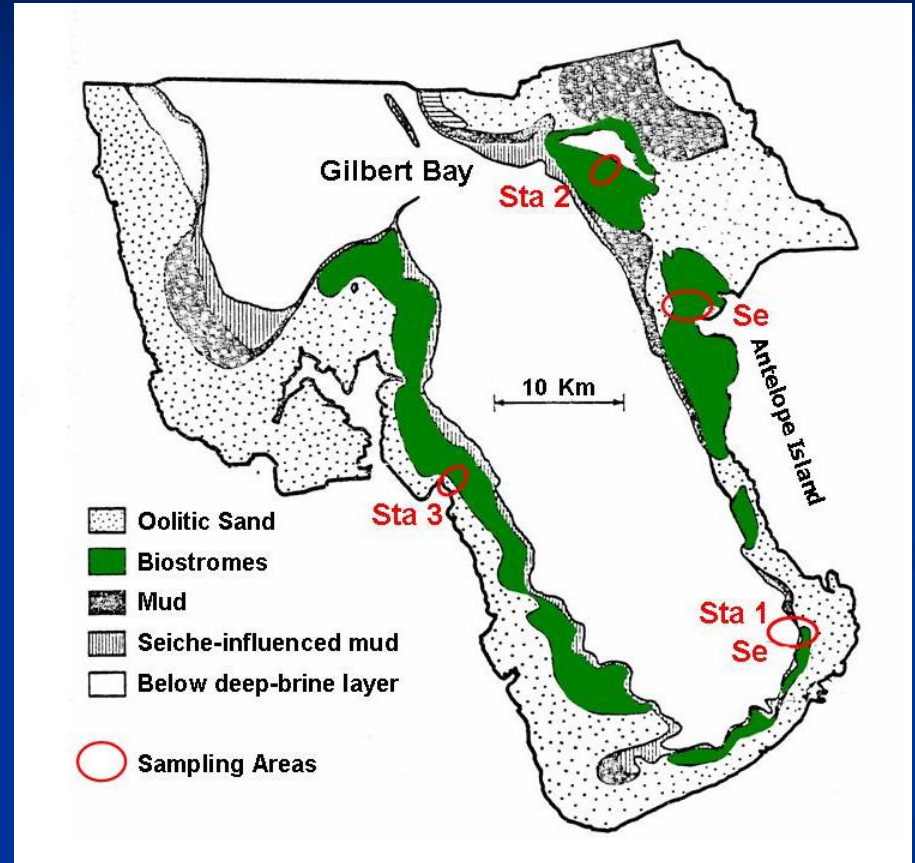
- Adults: 60 samples
- Cysts and Nauplii: 56 samples
- Cysts from streaks: 26 samples



Mercury in the Avian Diet

Wayne Wurtsbaugh, Utah State University

- THg in Brine Fly
 - Larve – 32 samples
 - Pupae – 15 samples
 - Adult – 10 samples
- THg in the Periphyton
 - 69 samples



Mercury in the Water column and sediments of GSL Wetlands (Farmington Bay, Ogden Bay and Bear River Bay)

Dave Naftz, US Geological Survey

- THg in the Water Column: 47 samples
- THg in the Sediments: 37 samples



Literature Benchmarks

- US EPA Aquatic Life Criteria for THg in Marine Waters = 25 ng/L
- Washington State Marine Sediment THg Standard: 410 ng/g
- US EPA Screening Value for Consumption = 0.3 THg ppm ww
- Evers Dietary Exposure Risk Ranges:
 - Low Risk in Diet < 0.05 mHg ppm (ww)
 - Moderate Risk in Diet 0.05 – 0.15 mHg ppm (ww)
 - High Risk in Diet 0.15 – 0.3 mHg1 ppm (ww)
 - Extra High Risk in Diet >0.3 mHg1 ppm (ww)
- Avian Liver Risk Ranges:
 - Low Risk < 0.89 mHg ppm (ww)
 - Moderate Risk 0.89 – 2.00 mHg ppm (ww)
 - High Risk 2.00 – 6.00 mHg1 ppm (ww)
 - Extra High Risk > 6.00 mHg1 ppm (ww)

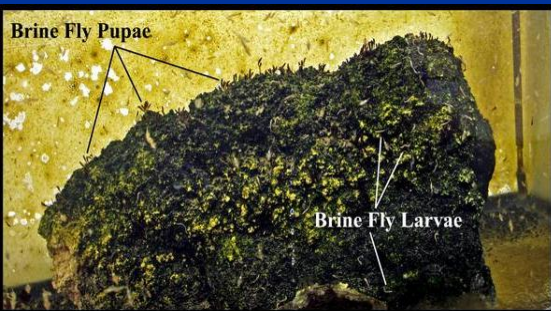
Great Salt Lake Simplified Food Web (open waters)

Birds



Brine Fly
(larvae, pupae
and adults)

Brine Shrimp (cysts, nauplii and adults)

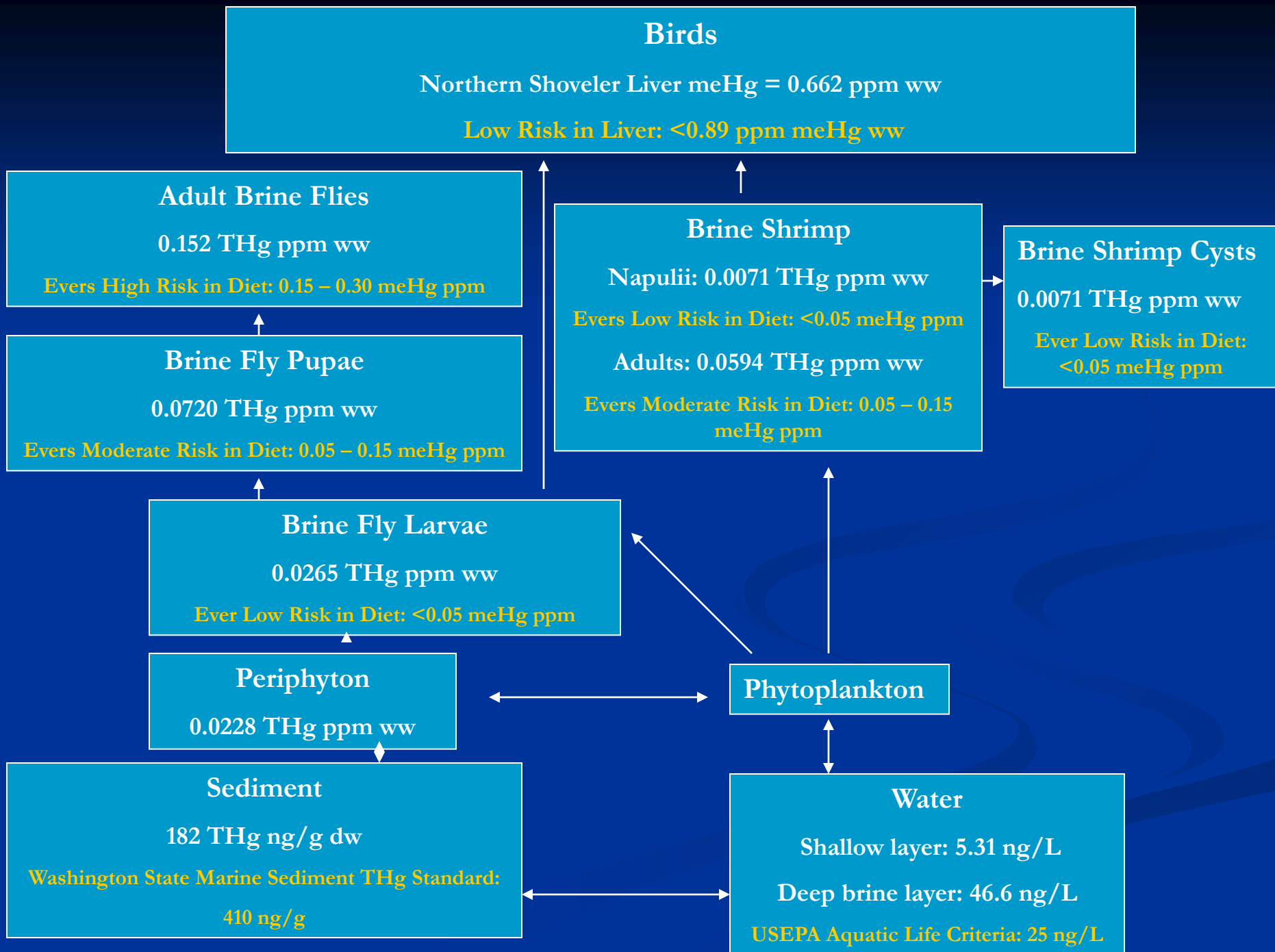


Periphyton

Phytoplankton



Sediment ↔ Water (deep brine and shallow layers)



Human Health Considerations

- EPA Screening Value = 0.3 mg of mercury/kg of fresh muscle tissue weight (ppm) ww

Species	2005 MeHg pp ww	2008 MeHg pp ww
Cinnamon Teal	0.42	0.163
Northern Shoveler	3.22	0.207

- Brine Shrimp Cysts mean MeHg = 0.0071 ppm ww

Utah Statewide Mercury Work Group Members

Organization	Representative
Anglers Group	Paul Dremann
Duck Club	Bruce Waddell
Environmental Organization	Maunsel Pearce
Power Generating Industry	James Campbell
Mining Representative	Tod Bingham
Department of Health	Christina McNaughton
Division of Wildlife Resources	Walt Donaldson
Division of Air Quality	Steve Packham
Division of Environmental Response & Remediation	Scott Everett
Dept. of Agriculture	Mark Martin
Division of Water Quality	John Whitehead
Local Health Department	Kevin Ockleberry
US Fish & Wildlife Service	Christine Cline
US Geological Survey	David Naftz
EPA Region 8	Jim Berkley
Great Salt Lakekeeper	Jeff Salt
Utah Medical Association	Jane Bowman
University of Utah	Bill Johnson
Tribal Interests	Jason Walker

Please Visit!

www.mercury.utah.gov

Advisories & Health

- ♦ [Fish Consumption Advisories](#)
- ♦ [Health Effects](#)
- ♦ [Map of Local Health Departments](#)
- ♦ [Mercury Toxicity](#)
- ♦ Moms & Kids
 - * [EPA's Fish Kids](#)
 - * [Eat Fish, Choose Wisely Presentation](#)
 - * [Sensitive Populations](#)
- ♦ [Utah Waterways Advisory Map](#)
- ♦ [Waterfowl Advisories](#)



Mercury Facts

- ♦ In the Environment
 - * [Bioaccumulation](#)
 - * [Mercury in Fish and Wildlife](#)
- ♦ Mercury Information
 - * [Atmospheric Transport](#)
 - * [Background](#)
 - * [Biogeochemistry](#)
 - * [Global Mercury Budget](#)
 - * [Sources](#)
- ♦ Spills and Proper Disposal
 - * [Disposal and Recycling](#)
 - * [Mercury in Products](#)
 - * [Mercury Spills](#)



Mercury in Utah

- ♦ [Get the Mercury Out!](#)
- ♦ [Healthy Hospitals Initiative](#)
- ♦ [Utah Information](#)

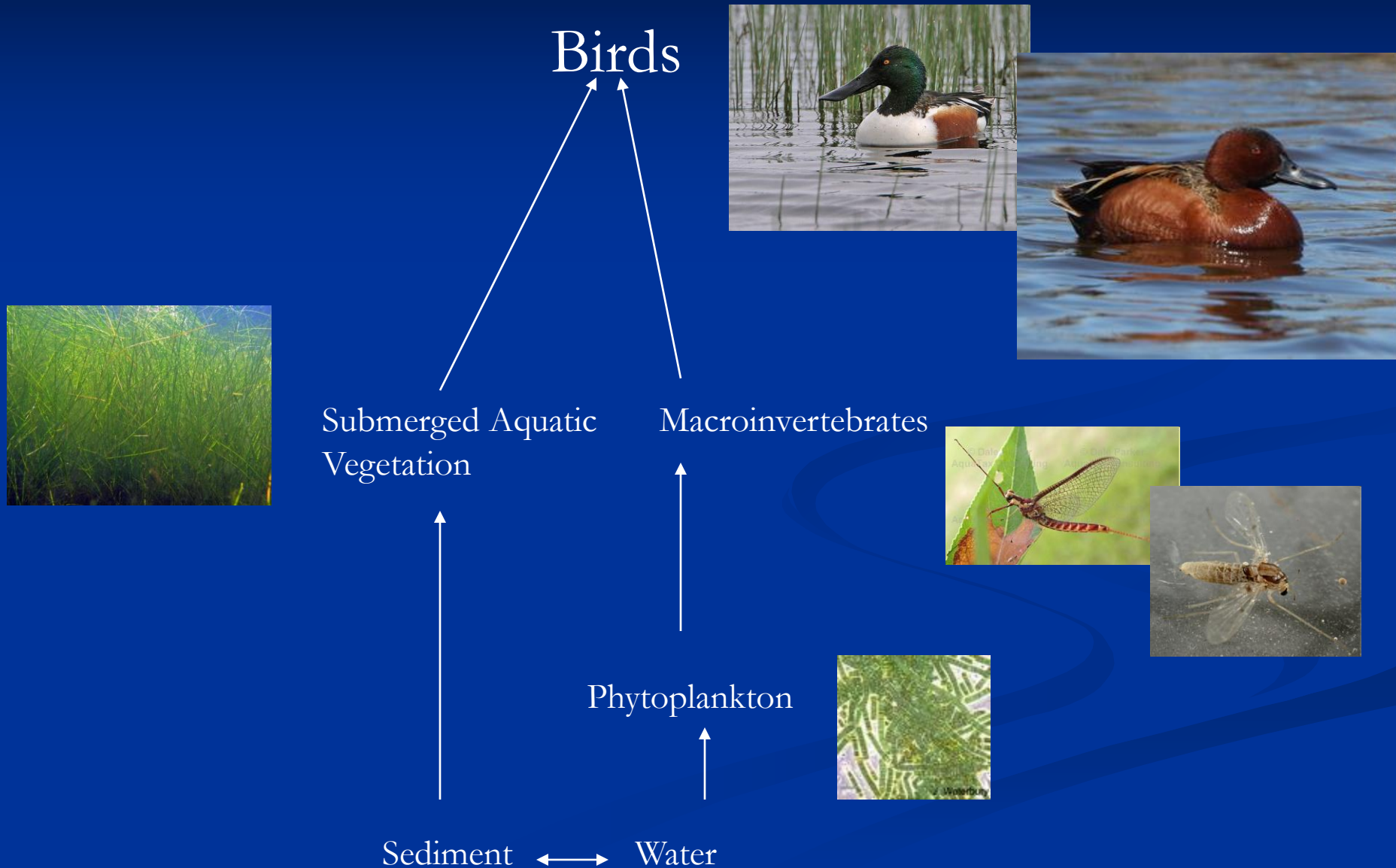


Mercury Workgroup

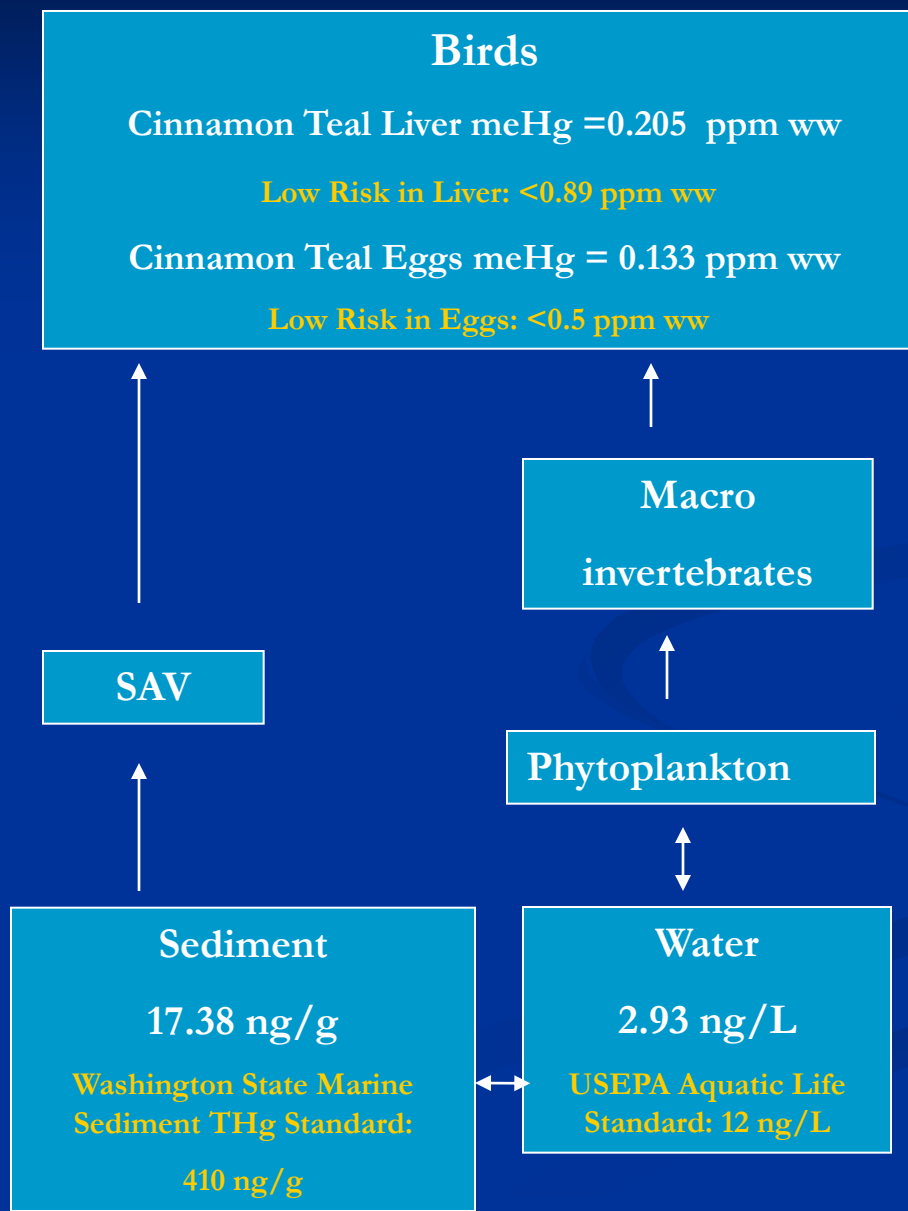
- ♦ [Mercury Work Group home page](#)
- ♦ [Process](#)
- ♦ [Email Listserv](#)
- ♦ [Workgroup Members](#)



Great Salt Lake Simplified Food Web (impounded wetlands)



Bear River Bay Wetlands



Ogden Bay Wetlands

Birds

Cinnamon Teal Liver meHg = 0.497 ppm ww

Low Risk in Liver: <0.89 ppm ww

Cinnamon Teal Eggs meHg = 0.246 ppm ww

Low Risk in Eggs: <0.5 ppm ww

Macro
invertebrates

SAV

Phytoplankton

Sediment

141.0 ng/g

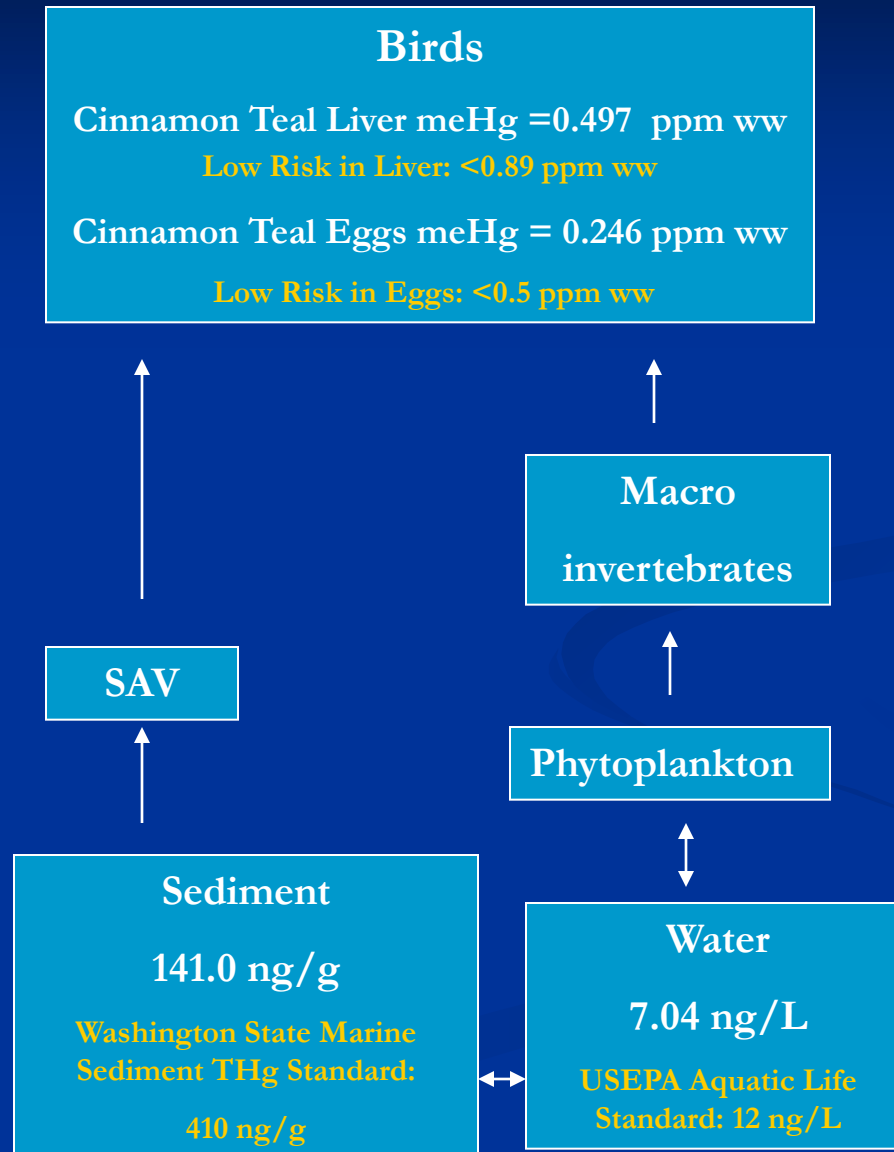
Washington State Marine
Sediment THg Standard:

410 ng/g

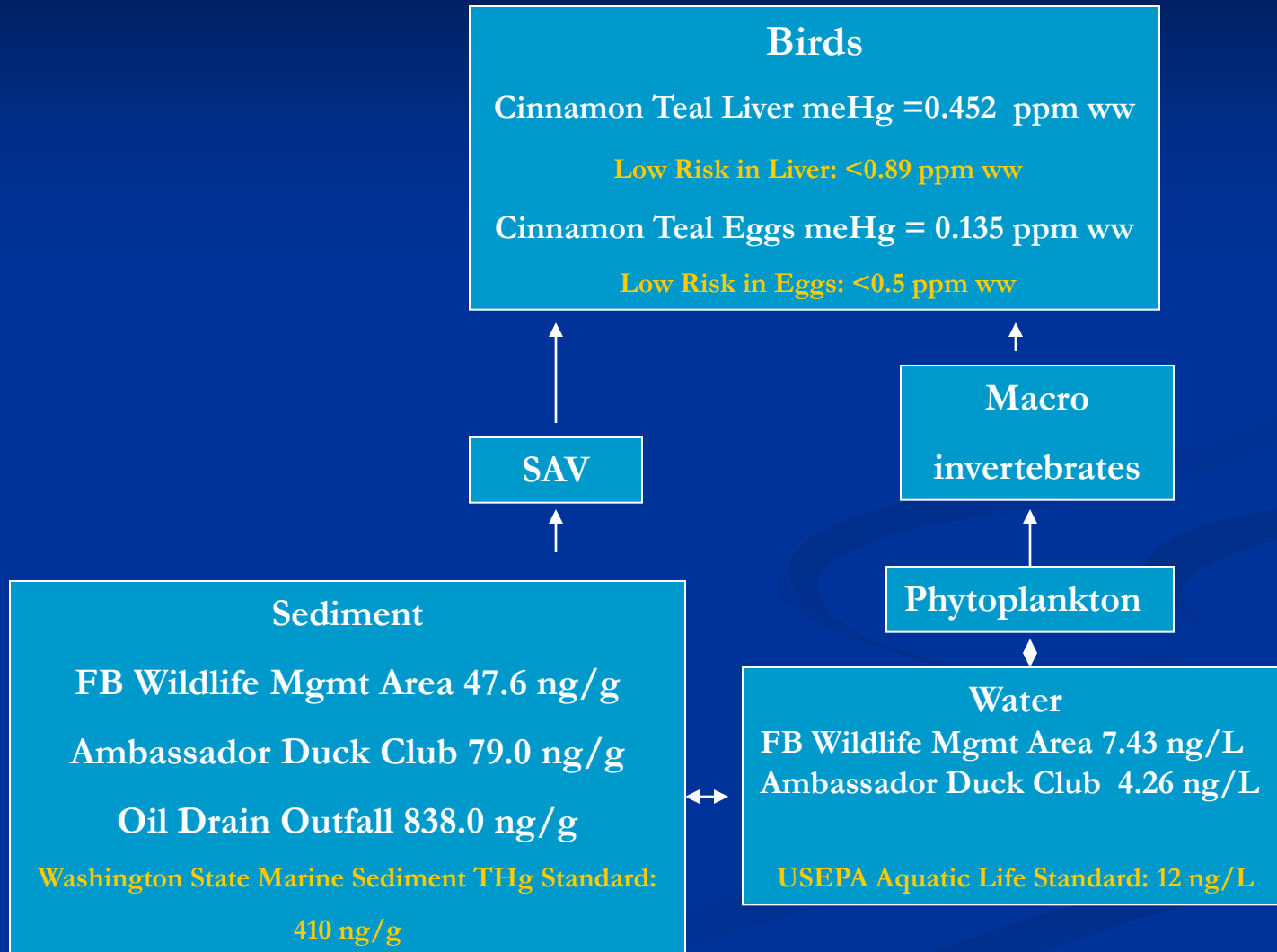
Water

7.04 ng/L

USEPA Aquatic Life
Standard: 12 ng/L



Farmington Bay Wetlands



Next steps

- Conduct research on Hg concentrations in the parts of the food chain that weren't part of this or other assessments (e.g. periphyton and algae)
- More Hg research on those avian species that feed primarily on brine shrimp and brine flies
- More Hg research on whether the avian species are exposed to Hg at the GSL or elsewhere
- Laboratory round robin to confirm and compare results
- Research on relationship between selenium and mercury
- Perform an Eco risk assessment